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INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY
(Chapter II of the Patent Cooperation Treaty)

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference P18804WO1	FOR FURTHER ACTION See Form PCT/IPEA/416	
International application No. PCT/SE2003/002040	International filing date (day/month/year) 19-12-2003	Priority date (day/month/year)
International Patent Classification (IPC) or national classification and IPC See Supplemental Box		
Applicant Telefonaktiebolaget LM Ericsson (publ) et al		

1. This report is the international preliminary examination report, established by this International Preliminary Examining Authority under Article 35 and transmitted to the applicant according to Article 36.
2. This REPORT consists of a total of 5 sheets, including this cover sheet.
3. This report is also accompanied by ANNEXES, comprising:
 - a. ☒ (sent to the applicant and to the International Bureau) a total of 6 sheets, as follows:
 - ☒ sheets of the description, claims and/or drawings which have been amended and are the basis of this report and/or sheets containing rectifications authorized by this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions).
 - ☐ sheets which supersede earlier sheets, but which this Authority considers contain an amendment that goes beyond the disclosure in the international application as filed, as indicated in item 4 of Box No. I and the Supplemental Box.
 - b. ☐ (sent to the International Bureau only) a total of (indicate type and number of electronic carrier(s))
_____, containing a sequence listing and/or tables related thereto, in electronic form only, as indicated in the Supplemental Box Relating to Sequence Listing (see Section 802 of the Administrative Instructions).

4. This report contains indications relating to the following items:

- | | | |
|-------------------------------------|--------------|---|
| <input checked="" type="checkbox"/> | Box No. I | Basis of the report |
| <input type="checkbox"/> | Box No. II | Priority |
| <input type="checkbox"/> | Box No. III | Non-establishment of opinion with regard to novelty, inventive step and industrial applicability |
| <input type="checkbox"/> | Box No. IV | Lack of unity of invention |
| <input checked="" type="checkbox"/> | Box No. V | Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement |
| <input type="checkbox"/> | Box No. VI | Certain documents cited |
| <input type="checkbox"/> | Box No. VII | Certain defects in the international application |
| <input type="checkbox"/> | Box No. VIII | Certain observations on the international application |

Date of submission of the demand 14-06-2005	Date of completion of this report 17-03-2006
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INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

International application No.

PCT/SE2003/002040

Supplemental Box

In case the space in any of the preceding boxes is not sufficient.

Continuation of: Cover sheet

International patent classification (IPC)

H04L 12/28 (2006.01)

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

International application No.

PCT/SE2003/002040

Box No. I Basis of the report

1. With regard to the language, this report is based on:

- ☒ the international application in the language in which it was filed
- ☐ a translation of the international application into _____ ,
which is the language of a translation furnished for the purposes of:
- ☐ international search (Rules 12.3(a) and 23.1(b))
- ☐ publication of the international application (Rule 12.4(a))
- ☐ international preliminary examination (Rules 55.2(a) and/or 55.3(a))

2. With regard to the elements of the international application, this report is based on (*replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report*):

- ☐ the international application as originally filed/furnished
- ☒ the description:
pages 1-19 as originally filed/furnished
pages* _____ received by this Authority on _____
pages* _____ received by this Authority on _____
- ☒ the claims:
pages _____ as originally filed/furnished
pages* _____ as amended (together with any statement) under Article 19
pages* 20-25 received by this Authority on 18-01-2006
pages* _____ received by this Authority on _____
- ☒ the drawings:
pages 1-2 as originally filed/furnished
pages* _____ received by this Authority on _____
pages* _____ received by this Authority on _____
- ☐ a sequence listing and/or any related table(s) – see Supplemental Box Relating to Sequence Listing.

3. ☐ The amendments have resulted in the cancellation of:

- ☐ the description, pages _____
- ☐ the claims, Nos. _____
- ☐ the drawings, sheets/figs _____
- ☐ the sequence listing (*specify*): _____
- ☐ any table(s) related to the sequence listing (*specify*): _____

4. ☐ This report has been established as if (some of) the amendments annexed to this report and listed below had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).

- ☐ the description, pages _____
- ☐ the claims, Nos. _____
- ☐ the drawings, sheets/figs _____
- ☐ the sequence listing (*specify*): _____
- ☐ any table(s) related to the sequence listing (*specify*): _____

* If item 4 applies, some or all of those sheets may be marked "superseded."

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

International application No.

PCT/SE2003/002040

Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Claims	<u>8-23</u>	YES
	Claims	<u>1-7, 24</u>	NO
Inventive step (IS)	Claims	<u>8-23</u>	YES
	Claims	<u>1-7, 24</u>	NO
Industrial applicability (IA)	Claims	<u>1-24</u>	YES
	Claims		NO

2. Citations and explanations (Rule 70.7)

The invention concerns a method and a multihop network comprising a reactive routing protocol and solves the problem of keeping the performance of a connection between two nodes optimized by way of adapting a resource of a multihop network upon discovering a topology change in the multihop network.

Cited Documents:

D1 Dongkyun k et al "Power-aware route maintenance protocol for mobile ad hoc networks" IEEE TELECOMMUNICATIONS, 23 Feb.-1 March 2003

D2 Roux N et al "Cost adaptive mechanism to provide network diversity for MANET reactive routing protocols" IEEE MILCOM 2000, 22-25 October 2000

Document D1 is considered to represent the closest prior art. D1 describes a reactive routing protocol to be used in a multihop (ad hoc) network, wherein a resource (route) of the multihop network is adapted in response to a topology change (energy consumption) in the multihop network so as to optimize the performance (minimizing transmission power) of a connection between a source and a destination node. The protocol is thereby improving a cost function, associated with power consumption between a source node and a destination node. (see page 501, section I-page 504, section III).

D2 describes a cost adaptive mechanism for MANET reactive routing protocols. D2, however, only describe a mechanism in which the destination and source nodes are participating in the route adaptation.

.../...

Supplemental Box

In case the space in any of the preceding boxes is not sufficient.
Continuation of: BOX V

In D1, section III.B and fig. 3 it is described how a change of route may be executed as a response to a topology change.

An active node (P) is participating in the optimization, meaning that node P determines which source node it will send a request for re-routing to after node P has discovered a change of state, which is caused by a topology change. Based on the initiation from node P the source node determines which new route, not including node P, to choose. One criteria for making that decision may be to determine which route that consume most energy, and thus should be changed.

The role of the neighboring node or active node during the suggested optimization process is unclear. Claim 1 does, however, state that an active node is involved in the optimization process. A multihop network which can operate in accordance with what is described in claim 1 therefore is already known from D1, and, thus, claim 1 fails to describe a novel invention.

As a consequence, also claims 2-7 fail to describe a novel invention.

Claim 24 only appear to suggest that a node may adapt a resource to optimize the performance of an established connection.

Such a procedure is already identified in D1 and, thus, also this claim fails to describe a novel invention.

As for the remaining independent claims 8 and 16, these claims suggest that a cost function is being calculated in at least one neighboring node. The neighboring node also determines possible consequences from adapting a resource in order to decide whether the node should adapt the resource or not. It is not considered obvious to apply such a feature to any of the cited documents. Consequently claims 8 and 16 are novel and involve an inventive step. The claims also are industrially applicable.

To sum up, claims 1-7 and 24 fails to describe a novel invention, while the invention according to claims 8-23 is novel, involves an inventive step and is industrially applicable.

WHAT IS CLAIMED IS:

1. A multihop network (100, 400) comprising:
 - a source node (102a, A);
 - at least one neighboring node (102b, 102d, 102e, 102g, 102i, 102j, 102p, 102o, F and G);
 - at least one active node (102f, 102h, 102k, 102l, B, C and D); and
 - a destination node (102m, E), characterized by said nodes implementing a reactive routing protocol where a resource of the multihop network is adapted by one of the neighboring nodes or active nodes in response to a topology change in the multihop network to optimize the performance of a connection (106) between said source node and said destination node.
2. The multihop network of Claim 1, wherein said resource includes one or more of the following:
 - a route (108);
 - a channel; or
 - physical layer parameters.
3. The multihop network of Claim 1, wherein said topology change includes one or more of the following:
 - movement of one of the nodes;
 - quality variations in a channel between said source node and said destination node;
 - changes in traffic patterns in the multihop network;
 - changes in transmit patterns in the multihop network; or
 - changes in resource allocations in the multihop network.
4. The multihop network of Claim 1, wherein said one of the neighboring nodes or active nodes adapts the resource in an opportunistic manner in response to an instantaneous topology change in the multihop network.
5. The multihop network of Claim 1, wherein said one of the neighboring nodes or active nodes adapts the resource in a distributed manner where at least one of the neighboring nodes (F, G) is inserted into the connection between said source node and

said destination node and where at least one of the active nodes (C, D) is removed from the connection between said source node and said destination node.

6. The multihop network of Claim 1, wherein said one of the neighboring nodes or active nodes adapts the resource in a distributed manner where at least one of the active nodes (C, D) is removed from the connection between said source node and said destination node.

7. The multihop network of Claim 1, wherein said one of the neighboring nodes or active nodes adapts the resource in a distributed manner to satisfy one or more of the following conditions:

- meet a carrier to interference ratio;
- ensure existing connections meet their carrier to interference ratios;
- minimize aggregate power in the multihop network; and
- uses lowest cost to connect said source node and said destination node.

8. A method (200) for optimizing the performance of a connection (106) between a source node (102a, A) and a destination node (102m, E) in a multihop network (100, 400), said method characterized by the steps of:

- transmitting (202) a beacon (302) containing a measure of performance for the connection (106) from at least one active node (102f, 102h, 102k, 102l, B, C and D) associated with the connection between the source node and the destination node;

- receiving (204) at least one of the transmitted beacons at at least one neighboring node (102b, 102d, 102e, 102g, 102i, 102j, 102p, 102o, F and G) associated with the connection between the source node and the destination node;

- calculating (206) at said at least one neighboring node a cost function based on the measure of performance in each received beacon;

- determining (208) at said at least one neighboring node whether the cost function for the connection between the source node and the destination node can be improved if said at least one neighboring node adapts at least one resource in the multihop network; and

- if yes, adapting (210) the at least one resource to improve the cost function for the connection between the source node and the destination node; or

if no, maintaining (212) the at least one resource in the connection between the source node and the destination node.

9. The method of Claim 8, wherein each active node performs the receiving step, the calculating step, the determining step, the adapting step and the maintaining step.
10. The method of Claim 9, wherein said at least one resource includes:
 - a route (108);
 - a channel; or
 - physical layer parameters.
11. The method of Claim 9, wherein said adapting step includes inserting at least one of the neighboring nodes into the connection between the source node and the destination node and removing at least one of the active nodes from the connection between the source node and the destination node.
12. The method of Claim 9, wherein said adapting step includes removing at least one of the active nodes from the connection between the source node and the destination node.
13. The method of Claim 8, wherein said adapting step is performed when there is a topology change within the multihop network, said topology change includes:
 - movement of one of the nodes;
 - quality variations in a channel between the source node and the destination node;
 - changes in traffic patterns within the multihop network;
 - changes in transmit patterns within the multihop network; or
 - changes in resource allocations within the multihop network.
14. The method of Claim 8, wherein said at least one neighboring node adapts the at least one resource of the multihop network in an opportunistic manner in response to an instantaneous topology change in the multihop network.

15. The method of Claim 8, wherein each beacon includes a general broadcast part (312) and a connection related part (314) that contains the measure of performance which includes:

an accumulated cost for the connection between the source node and the destination node; or

a maximum allowed power for the transmitting active node.

16. A wireless multihop network (100, 400) that implements a reactive routing protocol to optimize the performance of a connection (106) between a source node (102a, A) and a destination node (102m, E), said wireless multihop network characterized by:

at least one active node (102f, 102h, 102k, 102l, B, C and D) located in the connection between the source node and the destination node, wherein each active node performs the following step:

transmitting (202) a beacon (302) containing a measure of performance for the connection between the source node and the destination node;

at least one neighboring node (102b, 102d, 102e, 102g, 102i, 102j, 102p, 102o, F and G) associated with the connection between the source node and the destination node, wherein each neighboring node performs the following steps:

receiving (204) at least one of the transmitted beacons;

calculating (206) a cost function based on the measure of performance in each received beacon;

adapting (210) at least one resource in the wireless multihop network if it is possible to improve the cost function for the connection between the source node and the destination node.

17. The wireless multihop network of Claim 16, wherein each active node is performs the receiving step, the calculating step and the adapting step.

18. The wireless multihop network of Claim 16, wherein said at least one resource includes:

a route (108);

a channel; or

physical layer parameters.

19. The wireless multihop network of Claim 16, wherein said adapting step includes inserting at least one of the neighboring nodes into the connection between the source node and the destination node and removing at least one of the active nodes from the connection between the source node and the destination node.

20. The wireless multihop network of Claim 16, wherein said adapting step includes removing at least one of the active nodes from the connection between the source node and the destination node.

21. The wireless multihop network of Claim 16, wherein each neighboring node performs the adapting step when there is a topology change within the wireless multihop network, said topology change includes:

movement of one of the nodes;

quality variations in a channel between said source node and said destination node;

changes in traffic patterns within the wireless multihop network;

changes in transmit patterns within the wireless multihop network; or

changes in resource allocations within the multihop network.

22. The wireless multihop network of Claim 16, wherein each neighboring node performs the adapting step in an opportunistic manner when there is a real-time topology change within the wireless multihop network.

23. The wireless multihop network of Claim 16, wherein each beacon includes a general broadcast part and a connection related part that contains the measure of performance which includes:

an accumulated cost for the connection between the source node and the destination node; or

a maximum allowed power for transmitting active node.

24. A node (102b-102l, 102n-102g, B-D and F-G) which implements a reactive routing protocol (200) and adapts a resource within a wireless multihop network (100,

400) in response to a topology change within the wireless multihop network (100, 400) to optimize the performance of a connection (106) between a source node (102a, A) and a destination node (102m, E).